

Technically speaking

(continued from page 8)

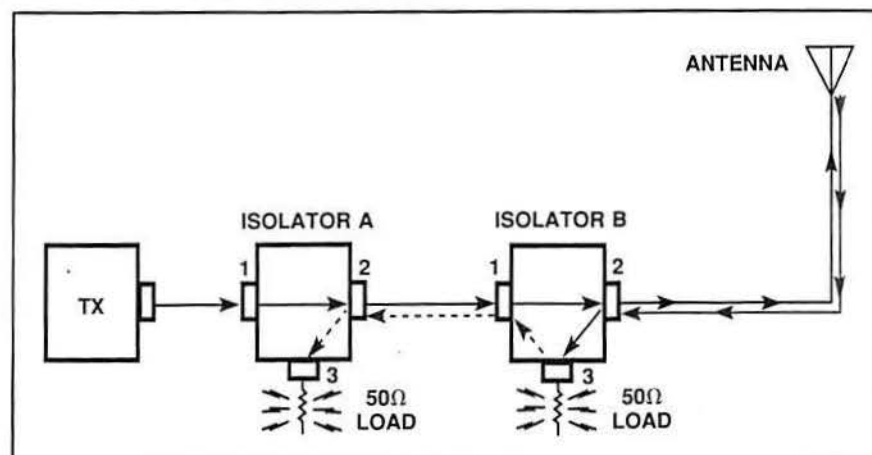


Figure 3. Two isolators can be connected in cascade to provide even greater isolation. The load resistor connected to port 3 of isolator B dissipates most of the reflected power, shown in red.

port 2 directly to port 3 and dissipated as heat by the dummy load at port 3. Any power reflected by the dummy load at port 3 is routed back to port 1 (broken red line) and thus back into the transmitter.

On the other hand, the RF level represented by the broken red line going to port 1 normally is much smaller than the RF level dissipated by the dummy load at port 3. Thus, most of the reflected power is dissipated as heat in

the dummy load and not returned to the transmitter through port 1.

Single-section vs. dual-section

When more isolation is desired than a single-section isolator can provide, two or more isolators can be connected in cascade to achieve the desired isolation.

Dual-section and even triple-section isolators are available from most isolator manufacturers. There are advantages and disadvantages to cascading single-section isolators or using dual-section or triple-section isolators or a combination.

Figure 3 to the left shows how two separate single-section isolators may be connected in cascade to provide additional isolation. If both isolators are identical, the isolation provided by two connected in cascade is twice that of one alone. At the same time, the insertion loss is twice (or more) that of a single section.

If there is a severe impedance mismatch at port 2 of isolator B, most of

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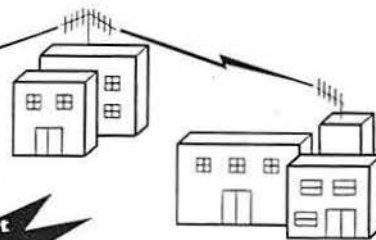
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the reflected power is directed into the load at port 3 of isolator B and is dissipated as heat. Because the load at port 3 of isolator B should provide a good impedance match, little power is reflected back into port 3 of isolator B and on to isolator A.

Nevertheless, any reflected power entering isolator A from isolator B is directed to the load at port 3 of isolator

A. The power dissipation of the load at port 3 of isolator A is small because the brunt of the reflected power is taken by the load at isolator B. Thus, the load connected to isolator A need not be as large as the load connected to isolator B.

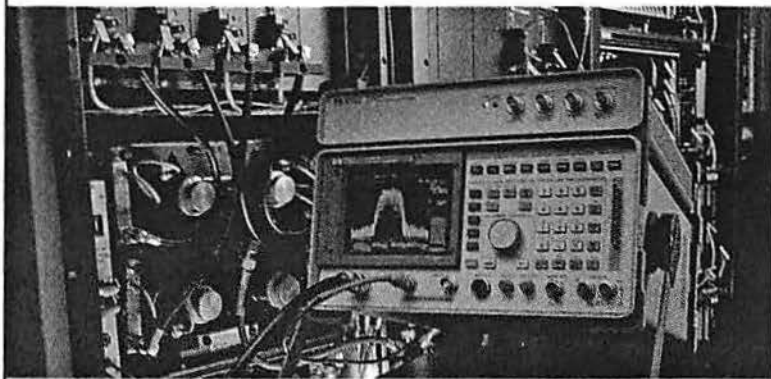
A dual-section isolator can provide the same isolation as two single-section isolators in cascade and cause

less insertion loss. In addition, a dual-section isolator costs less than two single-section isolators. Still, two single-section isolators are not *twice* as expensive as an equivalent dual-section isolator.

Another advantage of the dual-section isolator is that it is less cumbersome to connect because the interconnecting cable between the output of one isolator and the input of the next is eliminated, moreover, the dual-section isolator requires less space.

One advantage of using two single-section isolators instead of one dual-section isolator is the repair-and-

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A dual-section isolator can provide the same isolation as two single-section isolators in cascade and cause less insertion loss. In addition, a dual-section isolator costs less than two single-section isolators.

replacement factor. If one section of a dual-section isolator goes bad, the entire isolator must be replaced. Two single-section isolators can be tested and replaced separately, reducing replacement cost.

A further advantage of using two single-section isolators is to provide better dissipation because the heat generated is dissipated over a greater surface area.

Simple mathematical analysis

Refer to Figure 3.

Suppose that the two isolators, A and B, are identical single-section isolators with an isolation of approximately 20dB and an insertion loss of 0.35dB. Assume that the power input from the transmitter to port 1 of isolator A is 100W.

Technically speaking

Further assume that the return loss at the output of isolator B (port 2) is 10dB. According to Table 1 to the right this return loss is equivalent to a VSWR of 1.93:1. The forward power at the output of isolator B (port 2) is 0.7dB below 100W. (This 0.7dB is the combined insertion loss of the two isolators.) This insertion loss reduces the forward power to 85.1W.

Because the return loss is 10dB, the reflected power level is 8.5W at port 2 of isolator B. This reflected power is directed to port 3 of isolator B, where most of it is dissipated in the load.

This is a small loss—approximately 0.35dB—from ports 1 to 3 of isolator B, the same as the insertion loss from ports 1 to 2. This loss reduces the power appearing at port 3 to 0.35dB



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Table 1—Return loss vs. VSWR

Return Loss	VSWR
0	∞
1	17.39
2	8.72
3	5.85
4	4.42
5	3.57
6	3.01
7	2.62
8	2.32
9	2.10
10	1.93
11	1.78
12	1.67
13	1.58
14	1.50
15	1.43
16	1.38
17	1.33
18	1.29
19	1.25
20	1.22

below 8.5W or 7.8W. Assuming the load at port 3 of isolator B presents a good match with a return loss of 20dB (VSWR of 1.22:1), the power reflected back into port 3 is 0.07W or 78mW and is directed on to port 1 of isolator B.

The reflected power appearing at port 1 of isolator B is 0.35dB below 78mW or 72mW and passes on through the interconnecting cable to port 1 of isolator A to port 3 of isolator A. The reflected power appearing at port 3 of isolator A is 0.35dB below 72mW or 66.4mW.

Again, assuming the load at port 3 of isolator A presents a good match with a return loss of 20dB (VSWR of 1.22:1), the power reflected back into port 3 of isolator A is 0.664mW or 664μW.

Thus, at isolator A, a forward power of 100W enters port 1, and a reflected power of 612.6μW leaves port 1. The return loss is $10\log(100/0.000612) = 52.1\text{dB}$ or a VSWR of 1.005:1. This example shows how the isolator maintains a constant impedance match to the transmitter.

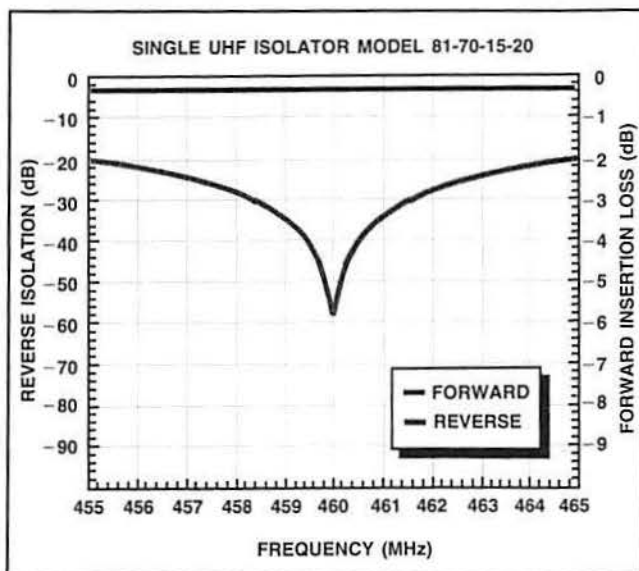


Figure 4. This graph shows both the insertion loss and the isolation with respect to frequency for a single-section isolator. (Courtesy TX RX Systems.)

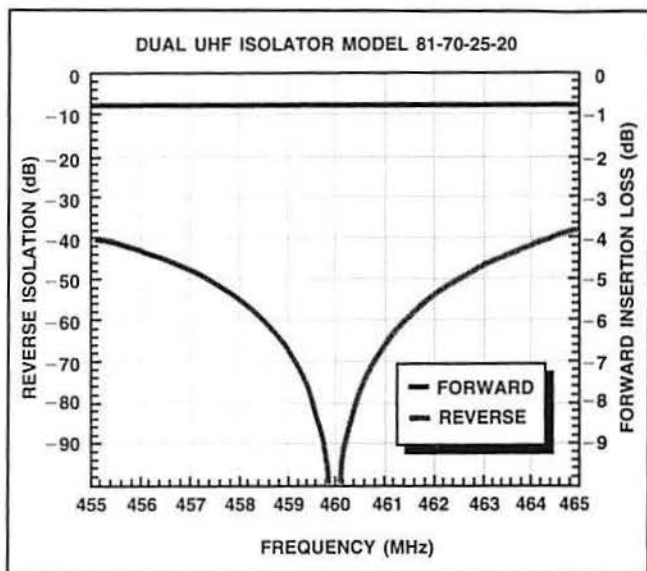


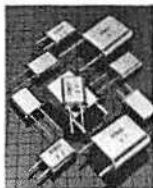
Figure 5. This graph shows the insertion loss and the isolation with respect to frequency for a dual-section isolator. (Courtesy TX RX Systems.)

Notice that the return loss at the transmitter output is 52.1dB while the return loss at the output of port 2 of

isolator B is 10dB. The return loss at the transmitter should equal the combined isolation figures of the isolators

plus the return loss at the output port of the final isolator plus the combined insertion loss figures of the isolators.

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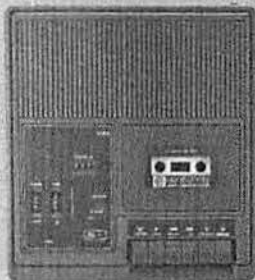
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In Figure 3, this is $20.7\text{dB} + 20.7\text{dB} + 10\text{dB} + 0.35\text{dB} + 0.35\text{dB} = 52.1\text{dB}$.

The isolation provided by the isolators in the example can be calculated using the formula:

$$\text{Isolation (dB)} = 10 \log(P2/P1)$$

where

P2 = reflected power at port 2

P1 = reflected power at port 1

In the example, the reflected power at port 2 of isolator B is 8.5W (P2) and the reflected power at port 1 is 72mW. Substituting into the formula:

$$\begin{aligned} \text{Isolation dB} \\ &= 10 \log(8.5/0.072) \\ &= 10 \log(118.055) \\ &= 20.7\text{dB} \end{aligned}$$

It is important that the load be properly matched to the isolator port. Any power reflected back into port 3 places an additional power dissipation requirement on the isolator.

The same formula can be applied to isolator A in the example, and the isolation figure comes out the same: 20.7dB. Typical isolation figures for single-section units are better than 30dB, so the performance would exceed that of the example.

Figure 4 on page 48 graphs isolation vs. frequency of a typical single-section isolator. The insertion loss vs. frequency also is shown.

Figure 5 on page 48 is a similar graph for a dual-section isolator. No-

tice that the isolation provided by the dual-section isolator is much greater than that provided by the single-section isolator. Notice, too, that the insertion loss of the dual-section isolator is greater.

Heat: The enemy

Heat is the number one enemy of isolators.

As long as isolator temperature is kept within the specified operating range, typically -30°C to $+60^{\circ}\text{C}$ or -22°F to $+140^{\circ}\text{F}$, the isolator should perform as specified. When the isolator is operated outside this temperature range, disaster can result. Here are some recommendations for avoiding such a disaster:

(1) Avoid exceeding the specified input power rating.

(2) Use a good-quality dummy load on the termination port.

It is important that the load be properly matched to the isolator port. Any power reflected back into port 3 places an additional power dissipation requirement on the isolator.

Further, the load should have good, thermally efficient radiating fins to radiate the heat instead of conducting it back into the isolator.

(3) Do everything possible to minimize the power reflected back into port 2 from the antenna, feedline and duplexer. Keeping the reflected power low sends less power into the dummy load and reduces the heat generated there.

(4) If it is necessary for the dummy load to dissipate much power, then consider physically separating the load from the isolator by using a well-shielded connecting cable. This separation reduces the heat transferred by conduction from the load to the isolator.

(5) Avoid placing the isolator in a high-ambient-temperature location.

If necessary, use fans to force air over the isolator to keep the temperature within safe operating limits.

(6) Use common sense.

Next month, we take a closer look at various isolator specifications and how to operate the devices within safe limits.



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Isolators—the practical view, part 2

By Harold Kinley, CET

In last month's column, some basic concepts of isolators were presented from a practical point of view.

This column includes some additional information about isolator use.

Input power vs. return loss

One isolator specification figure is input power rating.

If the reflected power is negligible (high return loss), then the isolator can be operated safely at full input power rating without exceeding its internal dissipation.

On the other hand, when the reflected power becomes significant, it increases the heating within the isolator and exceeds its maximum rated dissipation. To maintain a safety factor, the input power should be reduced to offset the increased dissipation caused by the reflected power.

Refer to Figure 1 above. Assume that both of the isolators shown in the figure are rated for 100W input power. The insertion loss is 0.35dB. The power input to isolator A is 100W (full

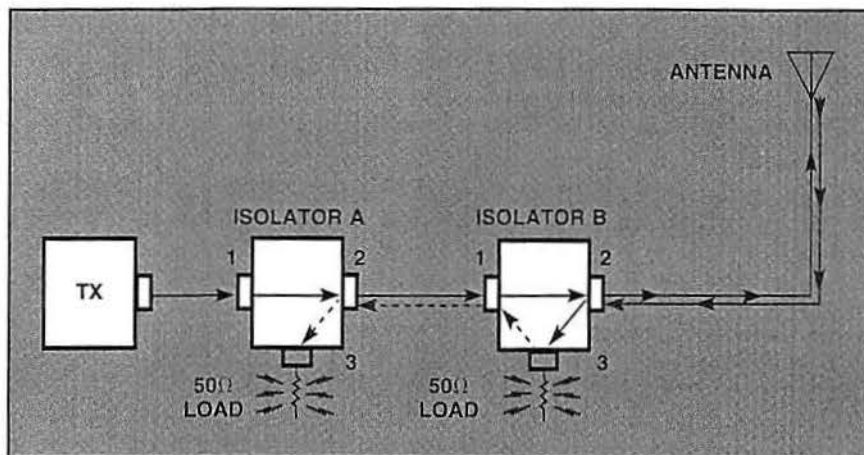


Figure 1. Two isolators can be connected in cascade to provide even greater isolation. The load resistor connected to port 3 of isolator B dissipates most of the power, shown in red.

rated power).

Because the insertion loss is 0.35dB, the output power at port 2 is 92.3W. Thus the power dissipated within the isolator is $100W - 92.3W = 7.7W$. To play it safe, 7.7W should be considered to be the isolator's maximum safe dissipation. As long as no reflected power enters the isolator and the input power does not exceed 100W, the in-

ternal dissipation will not exceed 7.7W.

When the load connected to the isolator output port is badly mismatched (low return loss, high VSWR), significant power is returned to port 2 and on to port 3 where it is "dumped" into the load. If the return loss is 3dB, for example ($VSWR = 5.85:1$), 50% of the output power from port 2 of the isolator reflects back into port 2 and travels to port 3 into the load.

In passing from port 2 to port 3, this reflected power causes increased dissipation within the isolator. If the isolator is operating at the 100W maximum input power, the output power from port 2 is 92.3W. The reflected power is 46.2W. The reflected power appearing at port 3 is 42.6W. The extra dissipation caused by the reflected power is $46.2W - 42.6W = 3.6W$.

Because of the reflected power, the isolator must dissipate $7.7W + 3.6W = 11.3W$. To bring the internal dissipation back to a safe level, the input power should be reduced to compensate for the reflected power.

(continued on page 50)

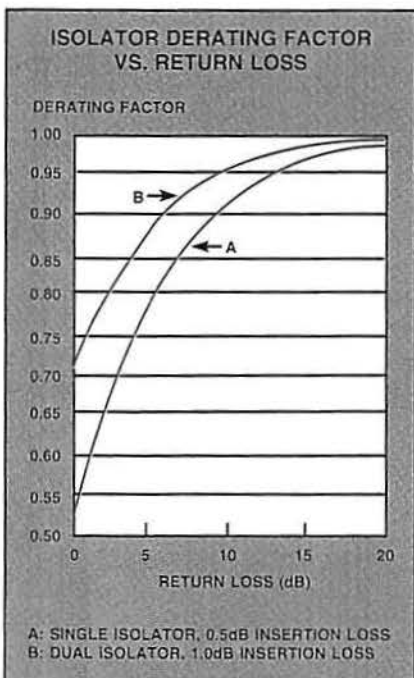


Figure 2. Use this graph to determine the derating factor to be applied to the input power for a given amount of return loss.

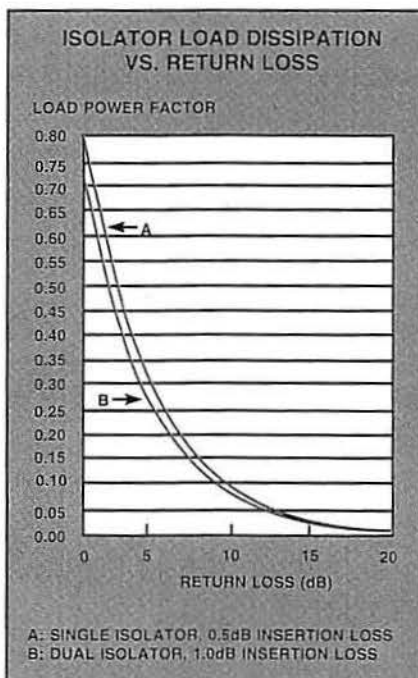


Figure 3. Use this graph to determine the required isolator load dissipation for a given amount of return loss.

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

Technically speaking

(continued from page 8)

The formula for finding the proper derating factor is:

$$F_d / (F_d + R_d)$$

where

F_d = forward power dissipation (watts)

R_d = reflected power dissipation (watts)

Because finding F_d and R_d is a bit tedious in itself, the following formula offers a quicker way to find the solution.

For single-section isolators:

$$D_f = \frac{1}{1 + \text{antilog} \left[\frac{(L+R)}{10} \right]}$$

where

D_f = derating factor

L = insertion loss

R = return loss

Be certain to enter L and R as negative values because they represent a loss.

$$D_f = \frac{1 + \text{antilog} \left[\frac{L}{20} \right]}{1 + \text{antilog} \left[\frac{L}{20} \right] + \text{antilog} \left[\frac{L+R}{10} \right]}$$

For dual-section isolators:

Again, be sure to enter L and R as negative values.

Figure 2 on page 8 can be used to find the derating factor for single-section isolators with 0.5dB insertion loss and for dual-section isolators with 1.0dB insertion loss.

For example, a certain single-section isolator has an input power rating of 150W under well-matched operating conditions (high return loss, low VSWR). Suppose that the return loss drops to 3dB. According to curve A on the graph in Figure 2, the derating fac-

tor for a return loss of 3dB is 0.69.

Thus, the normal input power rating should be reduced by a factor of 0.69. The reduced input power level should be no more than 69% of the specified maximum or $0.69 \times 150W = 103.5W$. This reduction compensates for the increased heating effect of the reflected power. For dual-section isolators, use curve B on the graph.

Dummy load size

Technically speaking, the dummy load connected to port 3 must be able to dissipate the full transmitter power if a worst-case mismatch occurs at the output (port 2). If such a worst-case mismatch occurs, almost all of the transmitter power will be "dumped" into the dummy load. If the load is incapable of dissipating this much power, the dummy load and possibly the isolator will be damaged from overheating.

Such worst-case mismatches indeed can occur, but usually what the designer wants to protect against is an-

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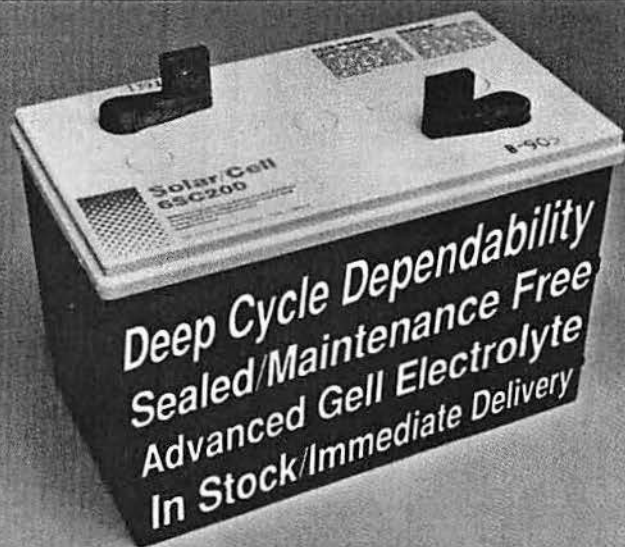
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tenna damage that causes the VSWR to soar and return loss to drop.

For example, if the isolator output is connected to an antenna through a feedline with a 1.5dB loss and a worst-case mismatch occurs at the antenna, the return loss at the feedline input will be 3.0dB. Thus, half of the output power will be dumped into the dummy load and dissipated as heat.

Usually, the size of the load is chosen to be approximately 50% of the transmitter output power; nonetheless, there are no hard and fast rules. Obviously, you would not elect to use a 200W dummy load if the transmitter were rated at 50W! Be conservative, but do not take it to the extreme. Use the common-sense approach.

The graphs in Figure 3 on page 8

can be used to determine the load requirements for a given amount of return loss. Curves are given for both single- and dual-section isolators.

As an example, suppose the return loss is 5dB. For a single-section isolator, the load requirement would be approximately 25% of the transmitter power. The following formula can be used to calculate the load requirement for a single-section isolator:

$$L_f = \text{antilog} \left[\frac{R+2L}{10} \right]$$

where

L_f = load factor

R = return loss in dB

L = insertion loss in dB

For dual-section isolators, the formula is:

$$L_f = \text{antilog} \left[\frac{R+1.5L}{10} \right]$$

Be sure to enter R and L as negative values.

Harmonics

In *Technical Papers* published by EMR, Phoenix, Bill Lieske writes:

"When RF power is conducted by the ferrite junction, harmonic responses are likely in most designs, and it is found that, possibly due to impurities or non-linearities in the ferrite mix and other phenomena, harmonic energy produced by a transmitter may be conducted through an isolator and, in some cases, weak harmonics can be generated in the ferrite material itself."

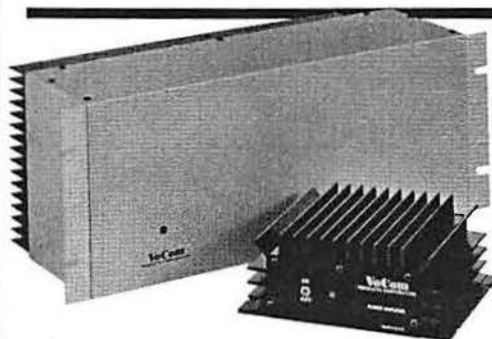
For that reason, it is important to use a harmonic filter between the isolator output and the antenna. (See Figure 4 on page 54.)

Moreover, if a *pass* cavity is connected between the isolator output and the antenna (as shown in Figure 5 on page 54), the harmonic filter is unnecessary. Figure 5 represents a typical repeater setup.

Isolator testing

After installing an isolator, you should confirm that it provides the iso-

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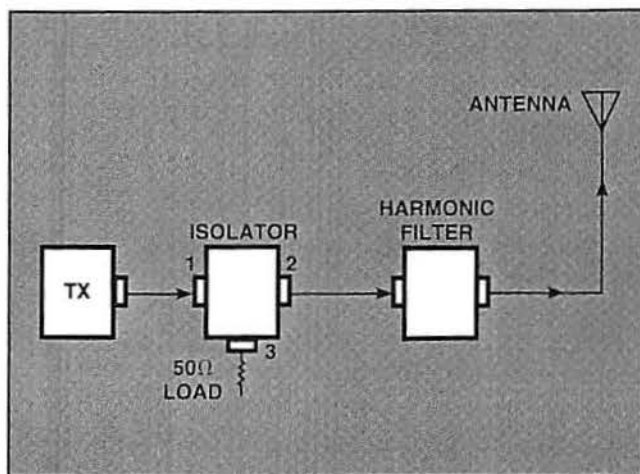


Figure 4. To suppress any harmonics caused by the isolator, a harmonic filter is used between the isolator output port and the antenna.

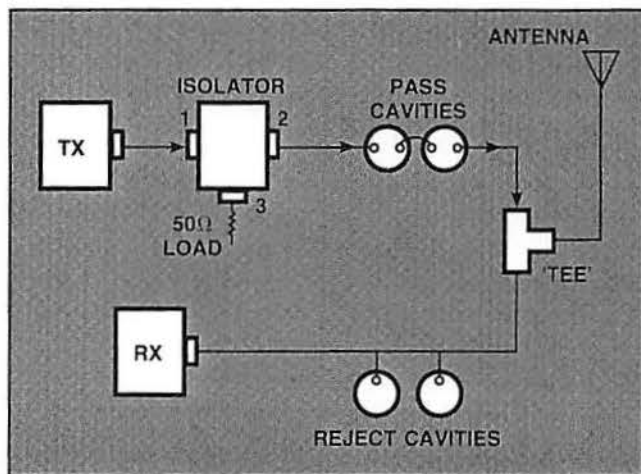


Figure 5. When a bandpass cavity follows the isolator, no special harmonic filter is needed. This configuration is typical of a repeater setup.

lation that the manufacturer specifies.

A simple way to measure isolation is shown in Figure 6 to the right. Set the signal generator to 0dBm, and measure the signal level (at the input port) on the spectrum analyzer.

First, feed the signal generator output directly into the spectrum analyzer to establish the 0dBm reference on the spectrum analyzer display. If the manufacturer specifies the isolation figure

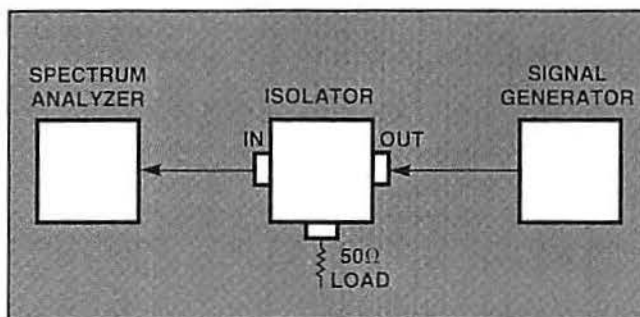


Figure 6. This setup is used to check the isolator's isolation figure. Notice that the signal is fed into the isolator output port while the measurement on the spectrum analyzer is taken at the input port. The difference between the signal generator level and the level measured on the spectrum analyzer is equal to the isolator's isolation figure.

to be 35dB, then the signal level measured on the spectrum analyzer should be at or below -35dBm. If you measure an isolation figure radically different from the specified figure, something is wrong, either in the isolator or in your test equipment.

The insertion loss should be checked, too.

Figure 7 on page 56 shows a simple way to measure the insertion loss. At (a), the forward power entering the input port is measured and re-

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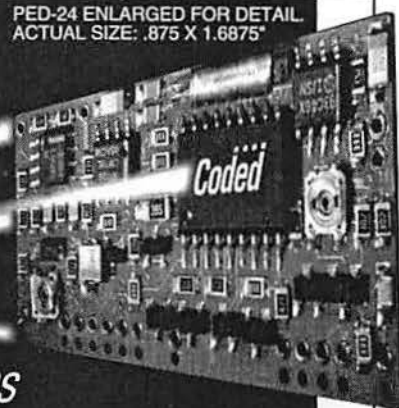
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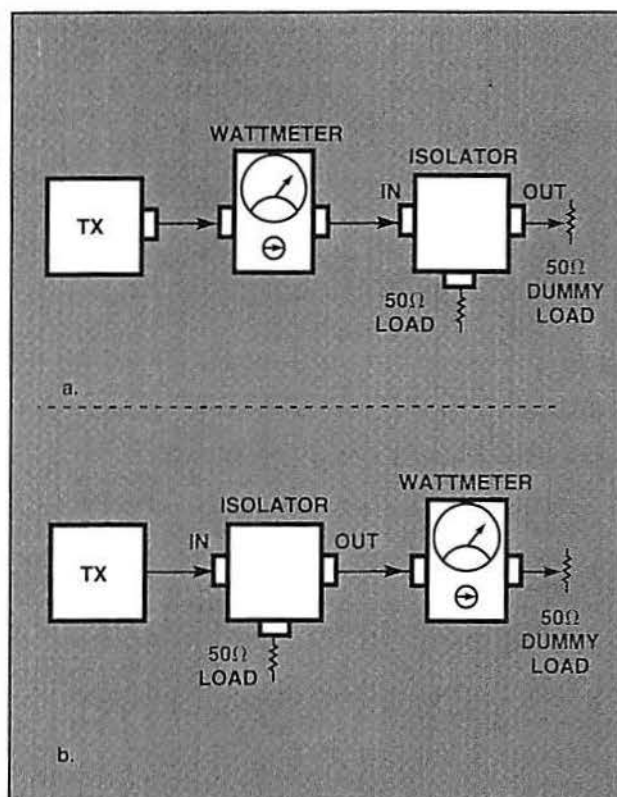
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Figure 7. This setup can be used to measure the isolator's insertion loss. At (a) the wattmeter measures the input power to the isolator. At (b) the wattmeter measures the isolator output power. The insertion loss then is determined by the formula $10 \log(P_i/P_o)$.



recorded as P_i . At (b), the forward power exiting the output port is measured and recorded as P_o . The insertion loss then is found by using the formula:

$$\text{Insertion loss} = 10 \log(P_i/P_o)$$

For example, if the input power P_i is 100W and the output power P_o is 90W, the insertion loss is $10 \log(100/90) = 10 \log(1.111) = 0.46\text{dB}$. Any radical departure from the specified figure should be investigated more closely.

Simplex base station hookup

When hooking up an isolator to a simplex base station, be certain to insert the isolator in the line between the transmitter output and the antenna relay.

If the isolator is inserted beyond the antenna relay (between the antenna relay and the antenna), the antenna will be effectively isolated from the receiver input, rendering the receiver virtually inoperative. (See Figure 8 on page 58.)

Proposed standard

Lieske offers the following information as a recommended standard to be used by transmitter site managers in controlling intermodulation interference among users:

"An RF isolator shall be provided immediately following each transmitter and shall provide a minimum of 30dB of isolation. In addition, the isolator shall be followed by a cavity resonator, harmonic, bandpass or lowpass filter to ensure that all conducted or generated harmonics are at least 100dB below the transmitter carrier power measured at the antenna system feedpoint.

"In the event that an intermodulation product resulting in interference to any on-site receiver is traced to a given transmitter, additional isolators or isolator sections shall be provided as required to suppress intermodulation products to a non-interfering level.

"All isolators shall maintain the minimum of isolations herein defined throughout the ambient temperature ranges to be found at the site and up to the maximum duty cycle of the radio transmitter concerned.

"Should nuisance or destructive in-

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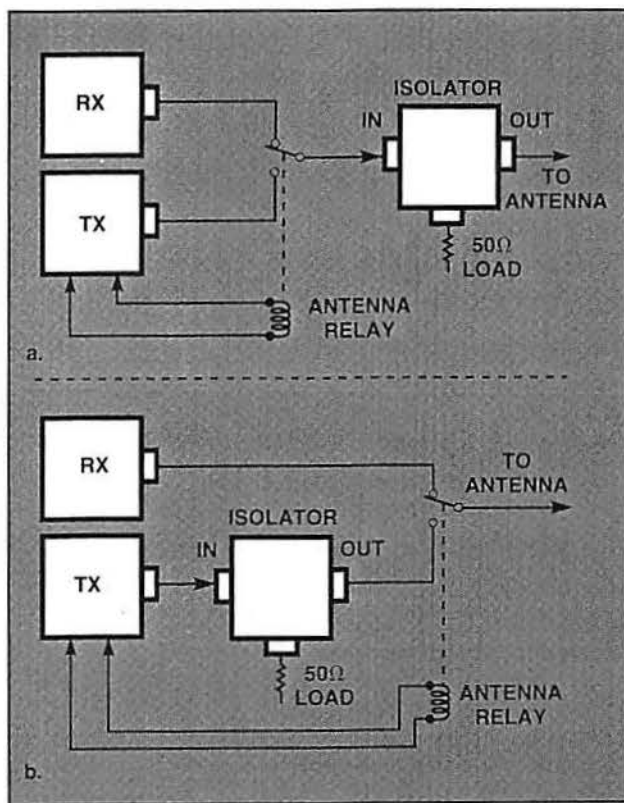


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Figure 8. At (a), the isolator is incorrectly inserted in the common antenna line to the transmitter and receiver. If this setup were used, little signal could reach the receiver input because the antenna is, in effect, isolated from the receiver. At (b), the isolator is installed between the transmitter output and the antenna relay. In this arrangement, the isolator is not between the antenna and the receiver input; thus, the received signal is not isolated from the receiver input.



interference still be found after the application of up to three cascaded isolators or three isolator sections, further reduction of intermodulation products shall be accomplished through (a) the addition of cavity filters, (b) through separation of antennas to reduce couplings, (c) a combination of (a) and (b), or (d) the adjustment of transmitter power output powers as needed to reduce the interference to an acceptable level."

It is hoped that this column, along with last month's, has answered some of your questions about isolators.

For the "purists," a computer program that computes the derating factor and the load requirement of typical isolators (single and dual) is available from the author at P.O. Box 15178, Spartanburg, SC 29302. The cost is \$5, including shipping and handling. The program is available only on a 5.25-inch floppy diskette in IBM format.

Additional information about isolators is available from various manufacturers.

Two manufacturers that can furnish additional tutorial information about isolators are: EMR, 22402 N. 19th Ave., Phoenix, AZ 85027; and Tx Rx Systems, 8625 Industrial Parkway, Angola, NY 14006.

References

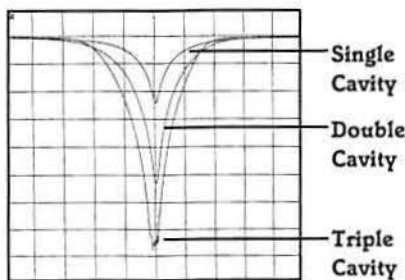
1. Alcivar, Ernesto A., "An Elementary Introduction To Ferrite Isolators, Circulators and RF Loads," Tx Rx Systems, Angola, NY, 1992.
2. "Ferrite Isolator Power Derating & Isolator Load Power Requirements," Tech-Aid Bulletin #92001, Tx Rx Systems, Angola, NY.
3. Lieske, William F., *Technical Papers*, EMR, Phoenix, 1991.

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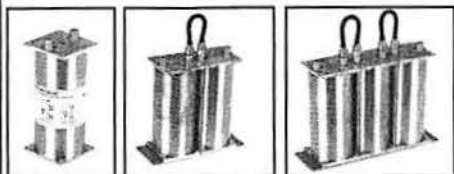
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Field-tuning isolators

By Harold Kinley, CET

The June and July columns covered ferrite isolators in some depth.

It is time to put the subject aside for a while—right after these few tips about field-tuning or retuning isolators.

The first and probably the best advice to give about the field-tuning of isolators is to follow the manufacturer's instructions to the letter. After all, the manufacturer knows the limitations and capabilities of his isolator better than anyone else.

General rules:

If possible, an isolator should be tuned in the installed position.

Generally, isolators should not be installed on a steel (or other ferrous metal) surface, but some manufacturers state that it is okay to do so as long as the tuning is "touched up" after installation.

If such isolators were tuned on a workbench and then installed on a steel

surface, it is likely that some detuning would result. The severity of the detuning would depend upon the degree of magnetic shielding the case provides.

Other manufacturers claim that their isolators are so well shielded that the mounting surface has a negligible effect on isolator tuning. Again, follow the manufacturer's instructions and use common sense.

Signal source

If you use the transmitter output as the signal source for tuning the isolator, reduce the transmitter power output to about 10% of the normal isolator power input rating (not to exceed 10W) while tuning the isolator. Once the isolator is tuned, normal rated input power can be applied to the isolator.

There are many accepted methods by which an isolator can be properly tuned. These methods range from very simple to fairly complex. The method you use will depend on the type of equipment you have available and just how much of a "purist" you are.

The methods presented here are not a complete compilation of all the possible ways to tune an isolator. There are probably at least 101 ways!

► **Single-section isolator**—The single-section isolator is the simplest to tune.

First, remove the caps to gain access to the tuning adjustments. A single-section isolator has three adjustments: *input port*, *output port* and *load port*.

The following procedure uses an in-line directional wattmeter as the measuring instrument and the transmitter as the signal source. (See Figure 1 below.)

(1) Figure 1A. Key the transmitter (low power) and tune the input port (1) and output port (2) for maximum power indication on the wattmeter.

(2) Figure 1B. Reverse the connections to ports 1 and 2. Key the transmitter and adjust the port 3 trimmer for minimum power indication.

► **Dual-section isolator**—The following system is used for numbering the various tuning adjustments for the dual isolator discussed in these procedures.

- 1 = input port of first section.
- 2 = output port of first section.
- 3 = input port of second section.
- 4 = output port of second section.
- 5 = load port of first section.
- 6 = load port of second section.

Procedure 1: This procedure uses an in-line directional wattmeter as the measuring instrument and the transmitter as the signal source. Refer to Figure 2 on page 68 for this procedure.

(1) With the setup shown at Figure 2A, key the transmitter and adjust trimmers 1, 2, 3 and 4 for maximum power indication. Repeat this adjustment sequence until no further improvement can be made.

(2) Using the setup at Figure 2B, key the transmitter and adjust trimmer 5 (load port of first section) for minimum power indication.

(3) Using the setup at Figure 2C, key the transmitter and adjust trimmer 6 for minimum power indication.

(4) With the test setup at 2D and with the transmitter keyed, there should be no discernible indication on the wattmeter.

(5) Measure the insertion loss and the isolation. If both are not within the manufacturer's specifications, repeat
(continued on page 68)

Kinley is a certified electronics technician with the South Carolina Forestry Commission, Spartanburg, SC. He is the author of *Standard Radio Communications Manual: With Instrumentation and Testing Techniques*, Prentice-Hall, 1985.

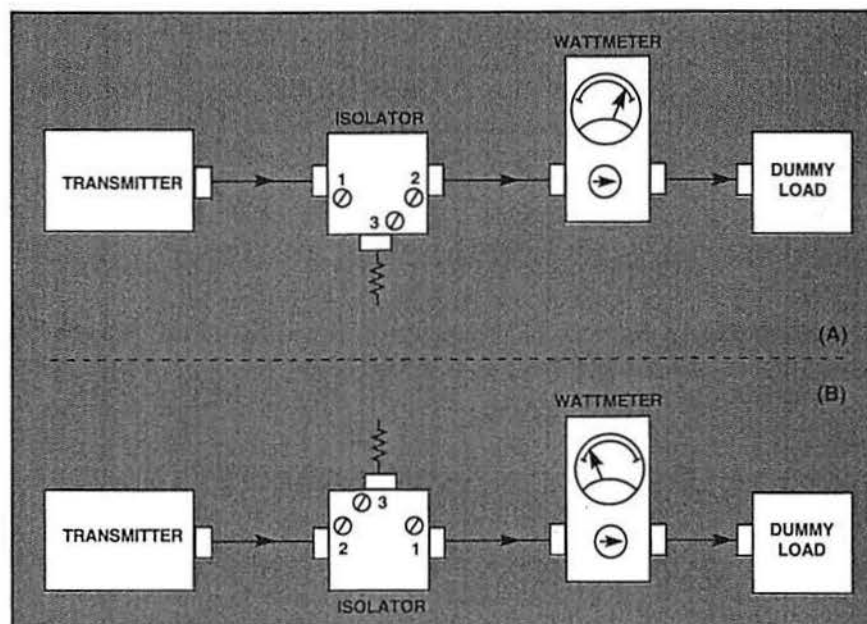


Figure 1. The single-section isolator is the simplest to tune. This diagram shows the equipment configurations to use with the two-step tuning procedure described in the text.

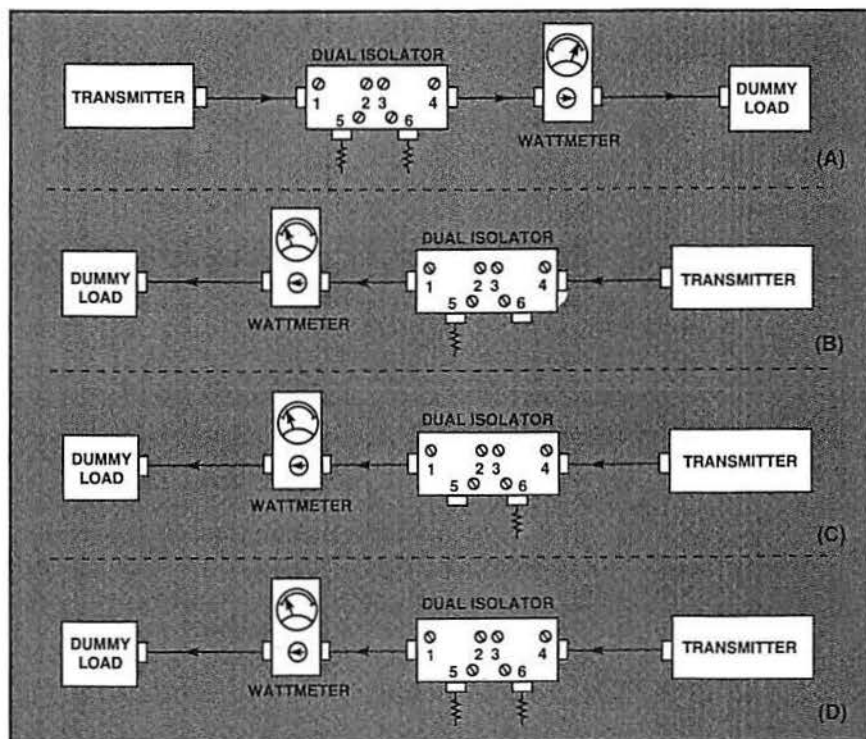


Figure 2. The first of three procedures for tuning dual-section isolators described in the text uses equipment configurations shown above.

(continued from page 8)

the tuning procedure.

Procedure 2: In this setup, a signal generator (highly stable) and a spectrum analyzer are used in place of the transmitter and wattmeter as the signal source and measurement instruments.

The signal generator frequency is set to the frequency to which the isolator is to be tuned. The spectrum analyzer is tuned to the same frequency.

If the spectrum analyzer is part of a service monitor, the frequency can be monitored on the frequency readout to keep the signal generator on frequency. If the signal generator is synthesized, you will not have to worry about frequency drift. Refer to Figure 3 on page 70 for this procedure.

(1) At Figure 3A, trimmers 1, 2, 3 & 4 are tuned for maximum indication on the spectrum analyzer display.

(2) At Figure 3B, trimmer 6 is adjusted for minimum indication on the spectrum analyzer display.

(3) At Figure 3C, trimmer 5 is ad-

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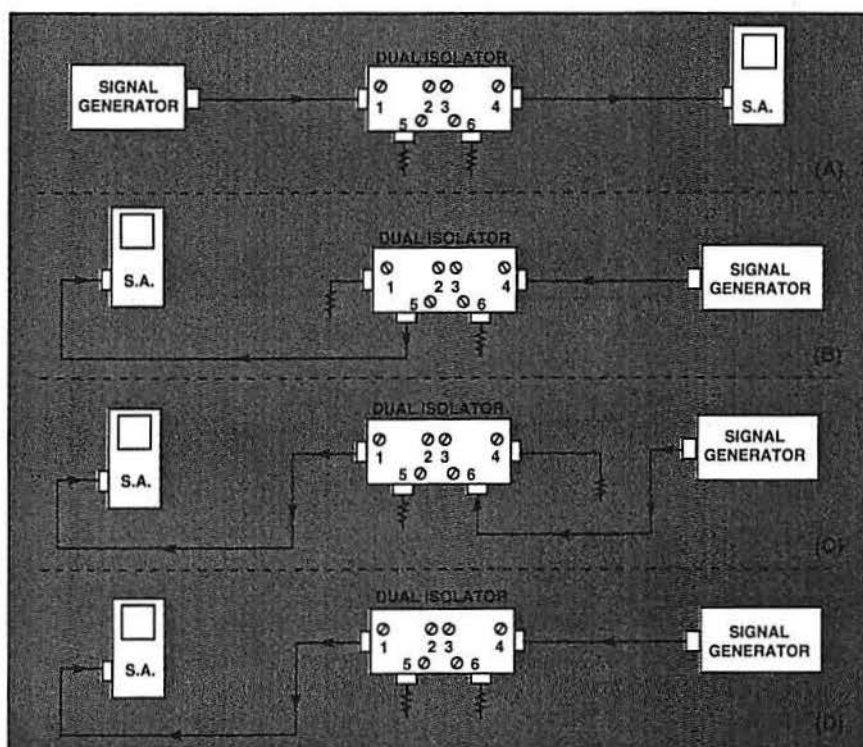


Figure 3. The second of three procedures for tuning dual-section isolators described in the text uses equipment configurations shown above.

justed for minimum indication on the spectrum analyzer display.

At Figure 3D, trimmers 5 and 6 are adjusted for minimum signal level on the display.

Procedure 3: The equipment required are a return loss bridge and spectrum analyzer-tracking generator combination. Refer to Figure 4 on page 72 for the following steps.

(1) At Figure 4A, trimmer 1 is adjusted for maximum return loss on the spectrum analyzer display.

(2) At Figure 4B, trimmer 4 is adjusted for maximum return loss on the spectrum analyzer display.

(3) At Figure 4C, trimmers 2 and 3 are adjusted for the best symmetry of the passband response of the isolator with the peak of the response curve at the desired center frequency.

(4) At Figure 4D, trimmer 5 is adjusted for minimum signal level on the display.

(5) At Figure 4E, trimmer 6 is adjusted for minimum signal level on the display.

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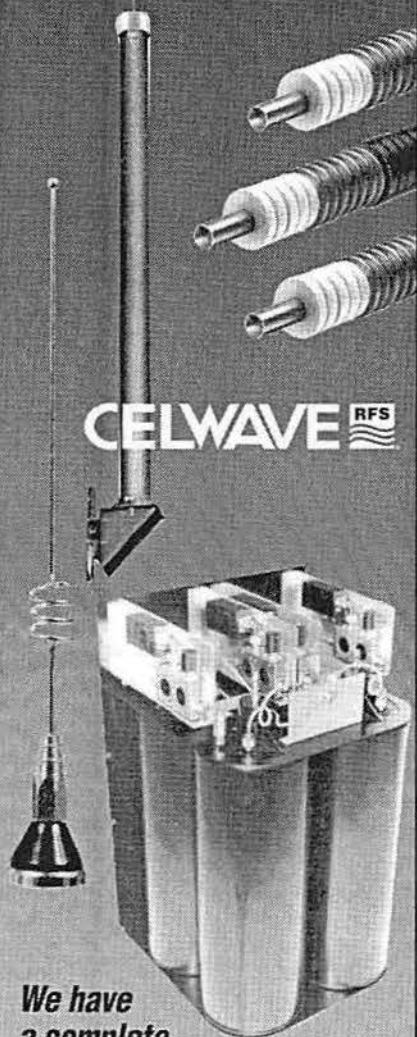


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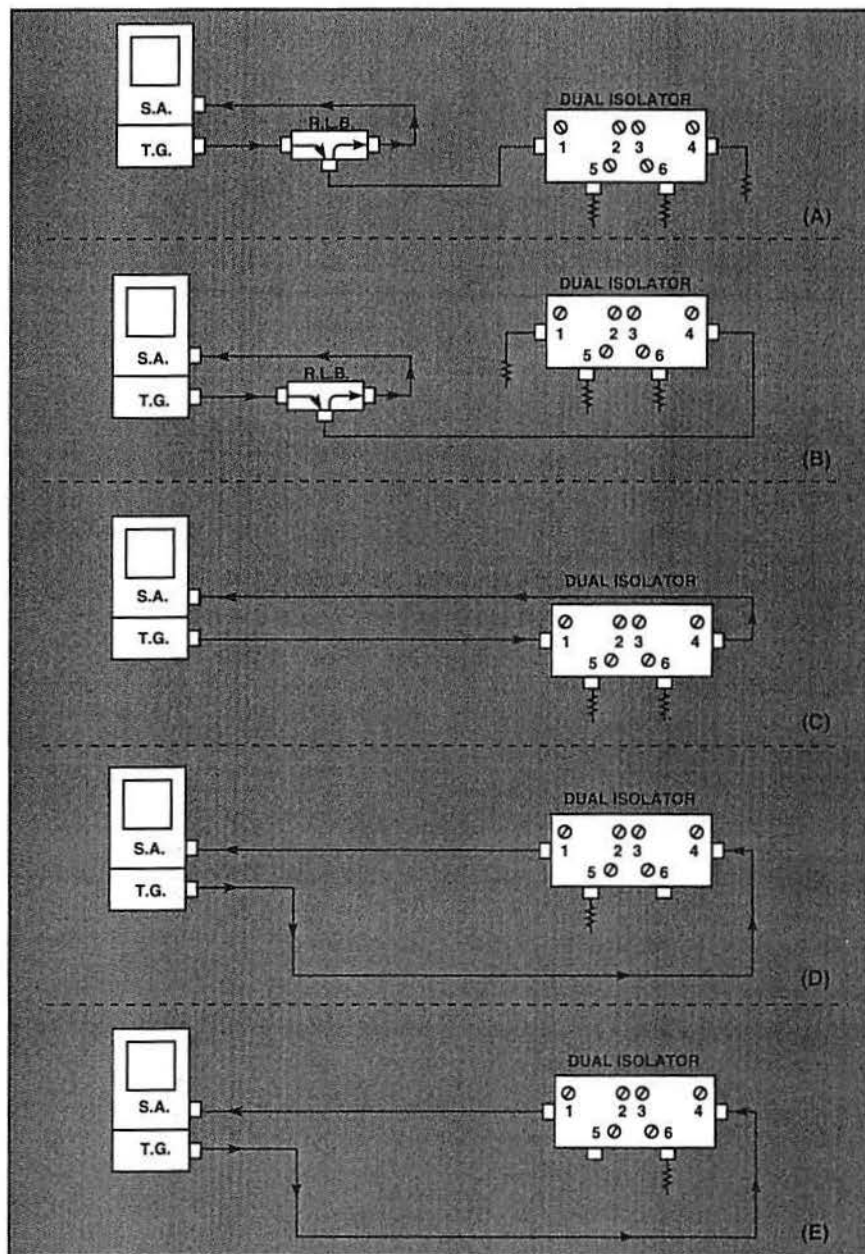


Figure 4. The third of three procedures for tuning dual-section isolators described in the text uses equipment configurations shown above.

Reconnect a load to port 5, and adjust trimmers 5 and 6 for minimum signal level on the display.

When tuning a dual isolator, never tune the load port trimmer with the associated load resistor removed. Remove one load at a time and adjust the opposite load port trimmer for maximum isolation (minimum signal level in the reverse direction).

After retuning an isolator, always check the insertion loss (forward direction) and isolation (reverse direction) and compare the results with the

manufacturer's specifications. If the measurements do not meet the specification, retune the isolator. If the isolator still does not come up to specifications, consult the manufacturer.

As stated, these procedures are not all-inclusive. There are many other variations that are correct and proper that will get the job done.

The procedure that you use will depend on you and your particular arsenal of test equipment. Again, use common sense, and consult the manufacturer when you are in doubt.

